Predicting Fertilizer Prices

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Current Situation

Fertilizer is a major expense item for farmers, currently accounting for around 20% percent of crop production expenses. As shown in Figure 1, the percentage of fertilizer expenses to total crop production expenses has varied across the state of Kansas both by region and by year. Western Kansas tends to apply less fertilizer as a percentage of total crop expenses than either central or eastern Kansas. Western Kansas has seen their fertilizer expense as a percentage of total crop expense increase over time, however, while the other two areas remain more constant.

From a dollar per acre perspective, fertilizer expense has ranged from $10 per acre to $70 per acre (in real dollars) depending upon the region of the state and the specific year. The western third of Kansas has seen fertilizer expenses of $10 to $40 per acre while the other two areas have seen fertilizer expenses from $20 to $70 per acre. Fertilizer expenditures per acre across all three areas of Kansas were at their low points from 1987 until 2005. Since then, fertilizers expenses per acre have risen until 2012. This increase in fertilizer costs per acre can probably be attributed to higher fertilizer prices, a shift in the crop mix to more corn, and higher grain prices which resulted in more fertilizer use. Since 2012, fertilizer costs per acre have declined for likely the same reasons they increased. Even with this decline, fertilizer costs per acre are double what they were back in the mid-1990's (in real dollars). Figure 2 shows these real dollar fertilizer expenditures per acre for Kansas Farm Management Association farms across the three regions of the state.

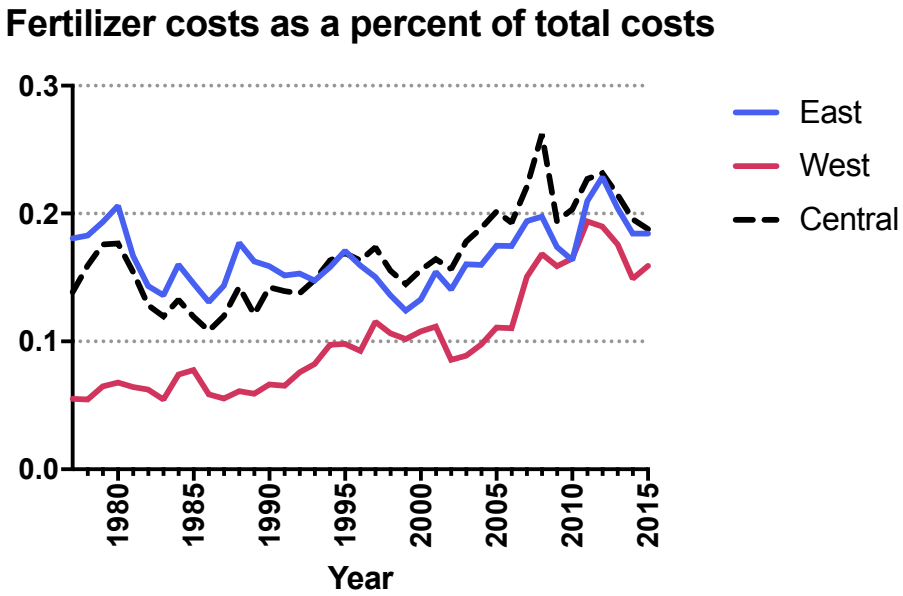

Figure 1. Fertilizer Cost Percentage by Region of Kansas (from KFMA data)

With current low grain prices (and the resulting lower profitability), producers need to manage their expenses very closely if they want an opportunity to earn any profits this year. Fertilizer is a good candidate for analysis, given that fertilizer is a major ex-

pense item both in absolute dollars and as a percentage of total production costs. If farmers could predict fertilizer prices 6 months to a year in advance, they could time their purchases to minimize costs, adjust their crop mix to account for either higher or lower fertilizer prices, and plan with their lenders to adjust operating loans to account for potentially higher or lower fertilizer prices.

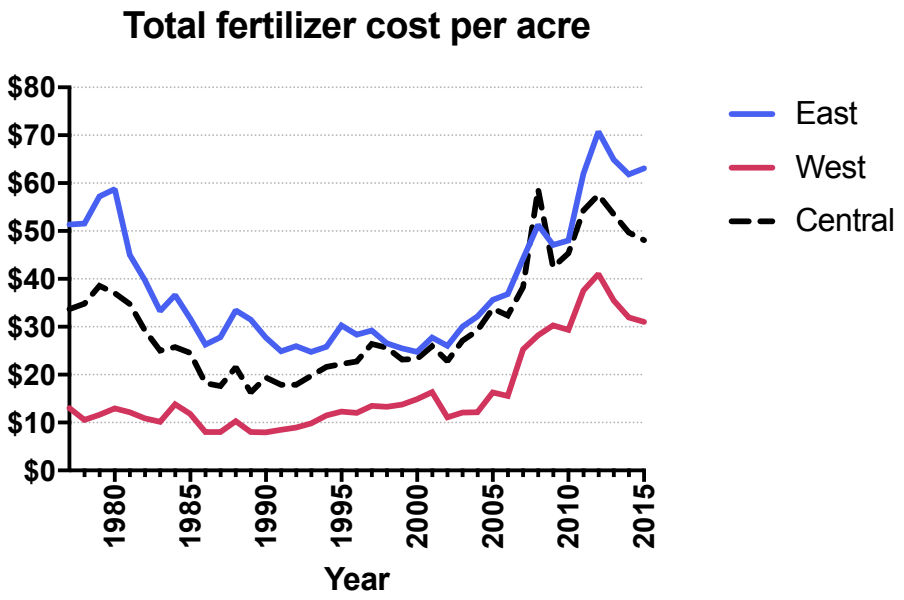

Figure 2. Fertilizer Cost in Real Dollars per Acre by Region of Kansas (from KFMA data)

Predicting anhydrous ammonia prices

Predicting nitrogen fertilizer prices is possible since the price of anhydrous ammonia is positively correlated with both the price of oil and corn. Nitrogen is one of the most important fertilizers in the production of corn, grain sorghum, and wheat so predicting anhydrous ammonia prices will cover a majority of the fertilizer expenses on a farm. Other nitrogen fertilizers start with ammonia so forecasting anhydrous ammonia provides an indication of prices for the other nitrogen products. In addition, anhydrous ammonia is positively correlated with other fertilizers besides nitrogen so correctly predicting anhydrous ammonia will give some indication of the price direction of other fertilizers.

Anhydrous ammonia is positively correlated with the corn price and the price oil because these two products represent something about the demand and supply of anhydrous ammonia fertilizer. Economic theory tells us that higher prices for an output will cause producers to produce more by using more of the production inputs. Thus higher corn prices lead to more nitrogen fertilizer per corn acre (i.e., increased demand for nitrogen fertilizer). Also, a higher corn price will shift more acres to corn (which uses nitrogen) and fewer acres to soybeans (which doesn't need nitrogen fertilizer). Figure 3 shows the relationship between the national anhydrous ammonia price and the national corn price since 2010 on a monthly basis. This monthly correlation is 0.84. National anhydrous ammonia prices come from the fertilizer reports published by Progressive Farmer (https://www.dtnpf.com/agriculture/web/ag/home). National monthly corn prices are from USDA Quick Stats.

The supply side of anhydrous ammonia is represented by the oil price. Ammonia is produced as a result of a catalytic reaction from burning natural gas (the hydrogen) and the nitrogen in the air. Thus, the expectation is that lower natural gas prices should lead to more production of ammonia. However, the correlation between monthly natural gas prices and monthly anhy-

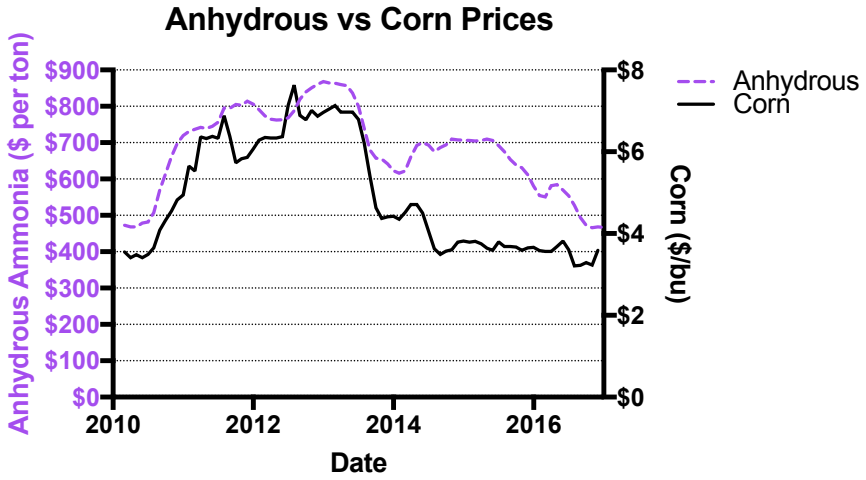

Figure 3. Monthly Anhydrous Ammonia Prices vs Monthly National Corn Prices

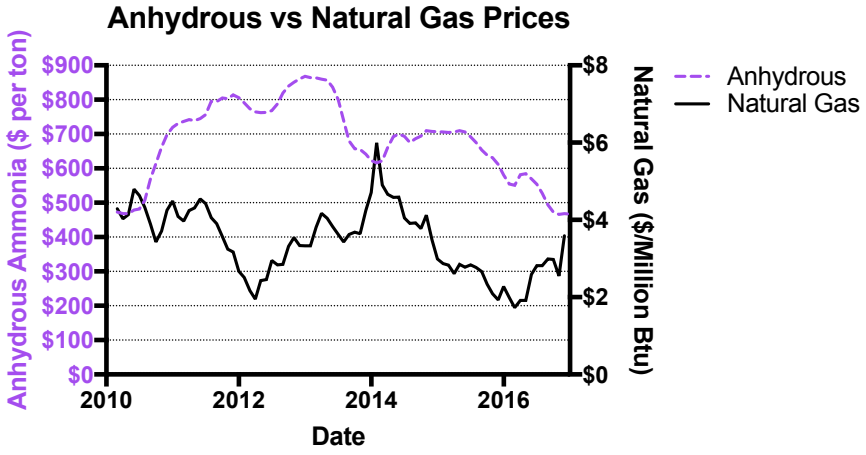

Figure 4. Monthly Anhydrous Ammonia Prices vs Monthly Natural Gas Prices

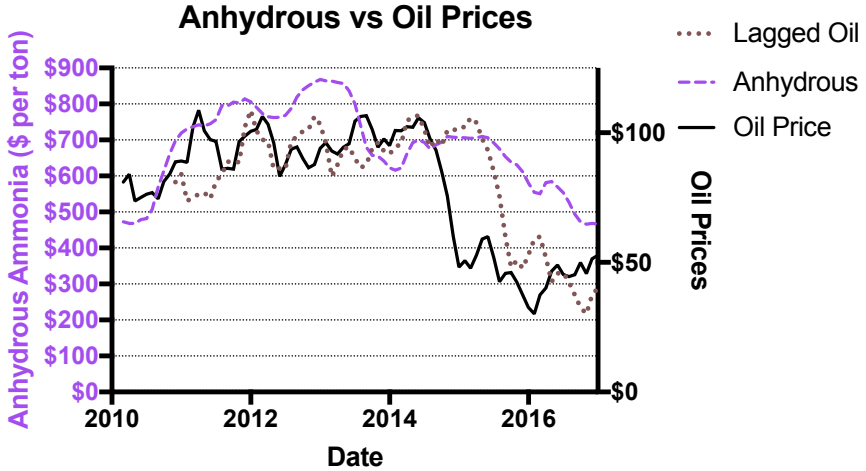

Figure 5. Monthly Anhydrous Ammonia Prices vs Monthly Oil Prices and Lagged Oil Prices

drous ammonia prices is low (0.01). This may be because natural gas prices are more volatile than other oil products. Schnitkey (Schnitkey, G. "Anhydrous Ammonia, Corn, and Natural Gas Prices Over Time." farm- doc daily (6):112, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, June 14, 2016) used yearly prices of corn and natural gas in a model to predict anhydrous ammonia prices and found that yearly natural gas prices worked well in a prediction model until 2008 when the correlation between natural gas and anhydrous ammonia became lower. Figure 4 shows the historical monthly prices of anhydrous ammonia and natural gas. Even allowing for a lag in the natural gas price didn't improve the correlation.

With monthly prices, the use of oil as opposed to natural gas provided a stronger correlation to anhydrous ammonia. Oil and natural gas can be substitutes for each other in certain situations and have a 0.59 correlation. The correlation between oil prices

and anhydrous ammonia prices is 0.55. However, a visual inspection of oil and anhydrous ammonia historical prices indicates that anhydrous ammonia prices tend to lag oil prices. This is not surprising as ammonia producers need some time to adjust production to account for changes in their input prices. Testing of various oil price lags revealed that a 10 month lag in oil prices provided the best fit to anhydrous ammonia prices. With this lag, the correlation between oil prices and anhydrous ammonia increases to 0.74. Figure 5 shows the historical monthly prices of anhydrous ammonia, oil, and the oil price lagged by 10 months.

Model to predict anhydrous ammonia prices

With the corn price representing the demand for anhydrous ammonia and the oil price representing the supply for anhydrous ammonia, a formal regression model was developed using ordinary least squares. This model resulted in the following equation:

*Anhydrous ammonia ($/ton) = 293 + 47.38 * corn ($/bu) + 2.09 * oil_10 mo lag ($/ barrel)*

This regression result has an adjusted R-squared of 0.86. An R-squared this high is usually considered a strong fit. Figure 6 shows the actual anhydrous ammonia price vs the predicted anhydrous ammonia price.

Predictions for 2017

During 2016, producers saw five-year lows in most fertilizers (See Figures 7, 8, 9, and 10 for historical prices of anhydrous ammonia, urea, MAP and potash). Given that nitrogen fertilizer prices are dependent upon corn prices and oil prices this result is unsurprising as oil and corn prices were low during 2016.

Going forward into 2017, producers are likely to see some increases in fertilizers prices due to higher oil prices. The model to predict anhydrous ammonia prices is based on a 10-month lag in oil prices. Thus, at the end of 2016, fertilizer prices were based on an oil price of $37.50 per barrel (spring of 2016 oil price). Oil

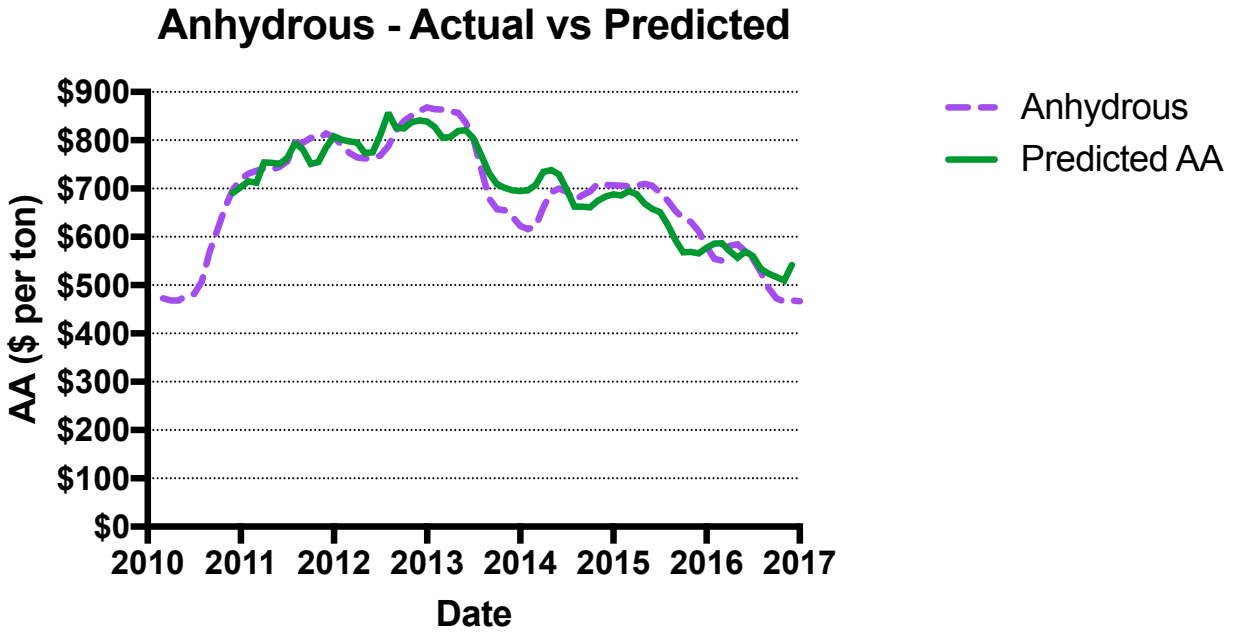

Figure 6. Actual vs Predicted Anhydrous Ammonia Prices

is already at $52 a barrel and the futures market is indicating that oil prices could be in the mid-50's this summer. Thus, a $15 increase in oil prices could add another $30 a ton to the anhydrous ammonia price by fall.

The other part of the price forecast concerns corn prices. A $0.10 change in the national corn price will move the predicted anhydrous ammonia price by $4.74 per ton. Unlike the forecast with oil prices (which is lagged by 10 months), the corn price effect has no lag. Thus, predicting anhydrous ammonia price movements with corn prices is trickier as we don't know these yet.

Other fertilizers are likely to increase during the course of 2017 as well as there is a strong positive correlation between anhydrous ammonia prices and the other fertilizer types (see Table 1).

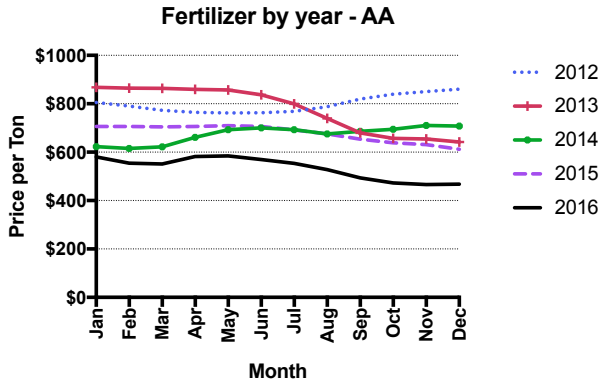

Figure 7. Historical Monthly Anhydrous Ammonia Prices by Year

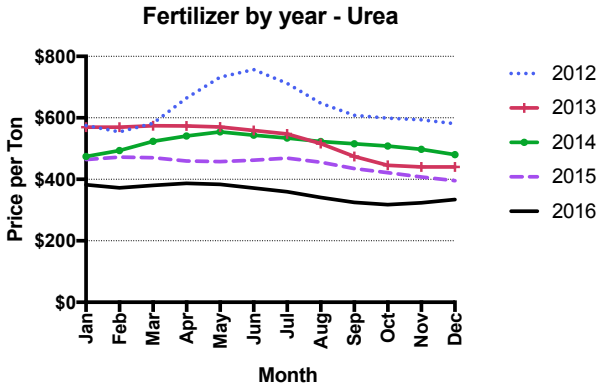

Figure 8. Historical Monthly Urea Prices by Year

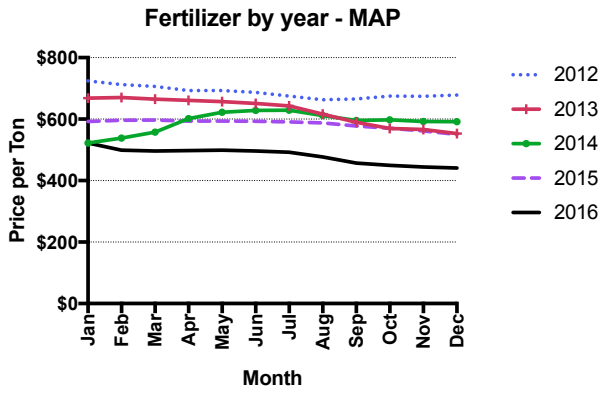

Figure 9. Historical Monthly MAP Prices by Year

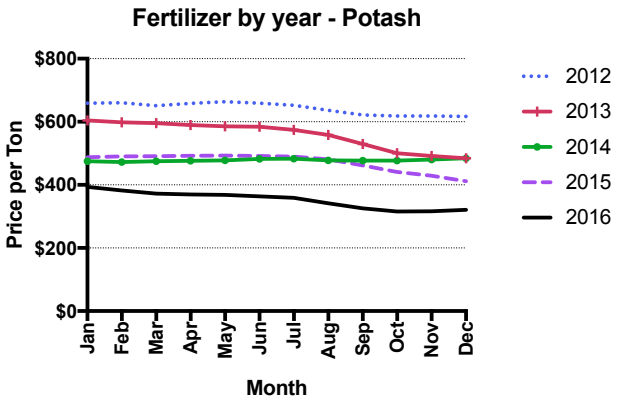

Figure 10. Historical Monthly Potash Prices by Year

Table 1. Correlation of Monthly Fertilizer Prices Since 2010

	Anhydrous	*Map*	*Urea*	*DAP*	*Potash*	*UAN28*	*UAN32*	*10-34-0*
Anhydrous	1							
Map	0.89	1						
Urea	0.83	0.83	1					
DAP	0.83	0.98	0.78	1				
Potash	0.82	0.92	0.88	0.88	1			
UAN28	0.93	0.93	0.93	0.89	0.90	1		
UAN32	0.93	0.92	0.93	0.86	0.89	0.99	1	
10-34-0	0.74	0.80	0.69	0.74	0.71	0.79	0.80	1

References

Kansas Farm Management Association (KFMA) data. AgManager.info.

NASS/USDA. Quick Stats. https://quickstats.nass.usda.gov

Progressive Farmer (https://www.dtnpf.com/agriculture/web/ag/home)

Schnitkey, G. "Anhydrous Ammonia, Corn, and Natural Gas Prices Over Time." *farmdoc daily* (6):112, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, June 14, 2016